Joint action malnutrition in the elderly (MaNuEL) knowledge hub

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SPECIAL ARTICLE

Joint action malnutrition in the elderly (MaNuEL) knowledge hub: summary of project findings

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Key summary points

Aim To summarize the main scientific results achieved during the 2-year Joint Action Malnutrition in the Elderly (MaNuEL) project and to outline the recommendations derived.

Findings Four systematic reviews, six secondary data analyses of existing cohort and intervention studies, two web-based surveys and one Delphi study were performed. In addition, a scoring system to rate malnutrition screening tools and a theoretical framework (DoMAP) on the aetiology of malnutrition in older persons were developed.

Message The MaNuEL Toolbox was made available to effectively distribute and disseminate the MaNuEL results and recommendations, which will support researchers, healthcare professionals, policy-makers as well as educational institutes to advance their efforts in tackling the increasing problem of protein–energy malnutrition in the older population.

Abstract

Purpose The Joint Action Malnutrition in the Elderly (MaNuEL) Knowledge Hub was established to extend scientific knowledge, strengthen evidence-based practice, build a sustainable, transnational network of experts and harmonize research and clinical practice in the field of protein–energy malnutrition in older persons. This paper aims to summarize the main scientific results achieved during the 2-year project and to outline the recommendations derived.

Methods 22 research groups from seven countries (Austria, France, Germany, Ireland, Spain, The Netherlands and New Zealand) worked together on 6 relevant domains of malnutrition—i.e. prevalence, screening, determinants, treatment, policy measures and education for health care professionals—making use of existing datasets, evidence and expert knowledge.

Results Four systematic reviews, six secondary data analyses of existing cohort and intervention studies, two web-based surveys and one Delphi study were performed. In addition, a scoring system to rate malnutrition screening tools and a theoretical framework on the aetiology of malnutrition in older persons were developed. Based on these activities and taking existing evidence into consideration, 13 clinical practice, 9 research and 4 policy recommendations were developed. The MaNuEL Toolbox was created and made available to effectively distribute and disseminate the MaNuEL results and recommendations.

D. Volkert and M. Visser (MaNuEL Knowledge Hub) made equal contributions to this paper.

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Conclusions The MaNuEL Knowledge Hub successfully achieved its aims. Results and recommendations will support researchers, healthcare professionals, policy-makers as well as educational institutes to advance their efforts in tackling the increasing problem of protein–energy malnutrition in the older population.

Keywords Protein–energy malnutrition · Aged · Prevalence · Screening · Treatment · Policy · Healthcare professionals · Education

Introduction

The Joint Action Malnutrition in the Elderly (MaNuEL) Knowledge Hub was launched in 2015 as part of the Strategic Research Agenda of the Joint Programming Initiative: A Healthy Diet for a Healthy Life (http://www.healthydietforhealthylife.eu). A consortium was built of 22 research groups from 7 countries (Austria, France, Germany, Ireland, Spain, The Netherlands and New Zealand). The consortium aimed to extend scientific knowledge; strengthen evidence-based practice in the management of malnutrition in older persons; build a sustainable, transnational, competent network of malnutrition experts; harmonize research and clinical practice [1].

To achieve these aims, MaNuEL focused specifically on protein–energy malnutrition and six relevant domains: (1) prevalence of malnutrition; (2) screening for malnutrition in different settings; (3) determinants of malnutrition; (4) effective nutritional interventions and future intervention studies; (5) current policies and practices regarding screening and treatment of malnutrition; (6) education of healthcare professionals regarding malnutrition screening and treatment in older persons across Europe.

This paper provides a summary of the main scientific results achieved in each domain during the 2-year project. In addition, clinical practice, research, policy and education recommendations within each domain are given (see Table 1).

Prevalence of malnutrition

It is well known among research and healthcare specialists that older persons are at increased risk of malnutrition and that malnutrition is widespread in this population group. Reported prevalence rates, however, vary widely between study samples. This can at least partly be attributed to different definitions and diagnostic criteria used. Thus, in the MaNuEL Knowledge Hub, the prevalence of malnutrition was calculated using several uniform definitions. In 15 national and international datasets available among MaNuEL partners, including a total of 5956 persons, based on BMI, weight loss, decrease in food intake and combinations of these parameters, we found that prevalence rates vary widely even when using the same definition in the same healthcare setting, e.g. BMI was <20 kg/m^2 in 4–18% of nursing home residents. Interestingly, prevalence rates at least doubled in all healthcare settings, when using the age-specific cut-off for low BMI defined by ESPEN (<20 kg/m^2 if age <70 years; <22 kg/m^2 if age ≥ 70 years [2]) instead of using the <20 kg/m^2 cut point for all age groups [3].

MaNuEL researchers also performed a systematic literature review and meta-analysis of prevalence rates of malnutrition risk and focused here on 22 malnutrition screening tools with acceptable validity for older adults in the specific setting in which they were tested (see also "Screening for malnutrition in different settings"). Of 196 studies, 223 study samples from 24 European countries with more than 580,000 older participants were included. Pooled prevalence rates of high malnutrition risk across all countries and screening tools were 28.0% for the hospital setting ($n=127$ study samples), 17.5% for residential care ($n=30$), and 8.5% for community-dwelling older people ($n=32$). Prevalence rates were higher in women, people aged at least 80 years and in patients with comorbidities, and varied by screening tool, between countries and by healthcare setting [4].

These results illustrate the importance of being always aware of the screening tool and the individual criteria used when interpreting screening results. As prevalence rates differ, depending on the tool used, the use of one preferred malnutrition screening tool per setting is strongly recommended. In parallel to the MaNuEL Knowldeg Hub, global consensus has been achieved on a scheme for diagnosing malnutrition [5] which is an important next step following positive screening for malnutrition. Besides validation of this diagnostic construct, however, future standardisation of its application and concrete diagnostic criteria and cut-off values are still required and strongly recommended.

Screening for malnutrition in different settings

Screening for malnutrition is the first step in diagnosing malnutrition in older persons. In the case of a positive result, a thorough nutritional assessment by a trained healthcare professional should follow. This two-step approach makes the diagnosis of malnutrition efficient as screening can be undertaken by personnel with less training while the more

Table 1 Recommendations regarding malnutrition (MN) in older adults from the MaNuEL Knowledge Hub

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	Clinical practice	Research
Prevalence of MN	• Standardization of diagnostic criteria per setting • As each criterion indicates at least risk of MN, look at each criterion separately and try to identify underlying causes	• Future standardisation of concrete diagnostic criteria and cut-off values is recommended
Screening of MN	• Always use a MN screening tool that has been validated in older persons and in the relevant healthcare setting • Find out whether the tool you are currently using is validated in older persons and for your health care setting	• Always use a MN screening tool that has been validated in older persons and in the relevant healthcare setting
Determinants of MN	• Be aware of potential MN risk in your patient especially in the case of functional impairment and hospitalization • Check which potential determinants are present in your individual patient • Identify factors which may be the cause of MN or increase the risk of MN • Think about options to remove the respective factors or provide remedy	• Assess determinants as comprehensive as possible • Use validated tools to assess determinants of MN
Treatment of MN	• Use ONS in combination with dietary counselling whenever possible – as part of a comprehensive, individualized intervention approach • Consider the evidence-based ESPEN guidelines to support your intervention decisions	• When conducting RCTs assess nutritional status, appetite and dietary intake for a comprehensive baseline characterization and monitor these variables during treatment • Also consider patient-centered outcomes such as quality of life and physical functioning • Obtain specific informed consent from your participants to allow the collected data to be used to address future research questions • Store all your original collected data • Share your datasets with other researchers to allow meta-analyses and pooled analyses
		Policy
Policy measures regarding MN	• Prevention, detection and management of MN should be obligatory included in medical treatment and should not depend on individual caregivers knowledge and engagement	• Implementation of binding norms for early detection and treatment of MN • Implementation of screening, treatment and monitoring of MN should be included in national health system policies on quality management in institutions
Education on MN	• Health professionals should receive training on screening for MN • Health professionals should be encouraged to follow additional courses (e.g. MOOC) to educate themselves on the topic of MN	• MN, multidisciplinary cooperation and evidence-based interventions needs to be included in the curriculum of nurses and physicians • Teachers with expertise in nutrition education, such as registered dietitians, should preferably be involved

time-consuming full assessment only needs to be performed older persons at high risk [6].

An in-depth literature search performed by MaNuEL researchers identified an overwhelming total of 48 malnutrition screening tools being applied to older persons in different settings (community, hospital, residential care and rehabilitation) [7]. As a first step to harmonize the future use of malnutrition screening tools, studies were selected in which malnutrition screening tools were validated in older adults. A total of 34 tools have been validated in 119 studies for use in this population group, mostly performed in the hospital setting. Of those studies, 93 assessed the criterion validity of the tool, for which 68 studies used an acceptable 'semi-gold' standard (defined as a clinical assessment by a

nutrition-trained professional, or—less preferably—the Mini Nutritional Assessment Full-Form, or the Subjective Global Assessment) as the reference method. The tools with the greatest evidence of validity (based on the validation study design and the results) were the Seniors in the Community—Risk Evaluation for Eating and Nutrition Questionnaire Version Two (SCREEN-II) in the community, the Malnutrition Universal Screening Tool (MUST) and the Malnutrition Screening Tool (MST) in hospitals, the Short Nutritional Assessment Questionnaire—Residential Care ($SNAQ^{RC}$) in residential care, and the Nutritional Form for the Elderly (NUFFE) in rehabilitation.

While high validity of a malnutrition screening tool in older persons is of course an important criterion for selecting a tool, other aspects are relevant as well, such as how easy it is to assess the parameters included in the tool, the ease and time it takes to apply the tool, and the type of staff that can apply the tool. MaNuEL researchers developed a scoring system to rate malnutrition screening tools for older persons and applied this system to all 48 malnutrition screening tools previously identified in the literature (see above) [8]. The scoring system consisted of three domains (validity, parameters and practicability) and within each domain a maximum score of 15 points could be obtained. The tools scoring highest were DETERMINE in the community, MNA-SF and MST in hospitals, $SNAQ^{rc}$ in residential care and NUFFE in rehabilitation.

Based on this MaNuEL research, two important recommendations can be made. First, it is paramount that a validated malnutrition screening tool is used and that it is setting specific. Second, the validity of currently used malnutrition screening tools should be assessed (especially in terms of the age group and setting in which they are used) (see [8]). Research activities should aim to identify one valid screening tool for each healthcare setting which reliably identifies those persons who will benefit from interventions.

Determinants of malnutrition

The origin of malnutrition is multifactorial, with a multitude of factors from various areas of life, e.g. physical function, health, cognition, mental status and social situation, involved. Since a common understanding of potential causes and their mode of action was lacking, one aim of the MaNuEL Knowledge Hub was to create a theoretical framework on the aetiology of malnutrition in older persons. Thus, a model of "Determinants of Malnutrition in Aged Persons" (DoMAP) was developed (Fig. 1). In a multistage consensus process with 2 live meetings and written feedback in 2 rounds (modified Delphi process), 25 MaNuEL partners and 8 external experts in the field of geriatric nutrition created and agreed to the model. DoMAP consists of three integrated triangle shapes with malnutrition in the centre. The three principal mechanisms by which malnutrition may develop are in the innermost triangle: these are low dietary intake, high nutritional requirements, and impaired nutrient bioavailability. The second triangle consists of 18 factors directly causing one of these mechanisms (e.g. chewing problems may directly cause low dietary intake), and the third triangle contains 27 factors indirectly causing one of the three mechanisms through the direct factors (e.g. oral pain or dry mouth may cause chewing problems). The triangles are surrounded by eight additional, general factors (e.g. multimorbidity, frailty), which also contribute to the development of malnutrition, but act in an even more indirect or subtle manner [9]. The DoMAP model intends to contribute to a common understanding of the many factors involved in the aetiology of malnutrition and about potential causative mechanisms. There is, however, no claim for completeness or objectivity, as by far not all factors discussed in the literature could be considered for reasons of clarity, and scientific evidence is currently limited and conflicting. Besides future scientific use, it may be helpful in clinical practice to identify persons at increased risk of malnutrition: concrete factors present in an individual patient can be recognized, checked for their impact on nutrition and nutritional status and subsequently addressed to remove the factor causing increased risk or providing an intervention to remedy the situation.

Despite sound reasons to assume a relationship between the factors included in the model and the development of malnutrition, scientific evidence is fragmentary and partly conflicting. Existing studies are difficult to compare since different sets of determinants, different assessment methods for determinants, different definitions of incident malnutrition and different statistical approaches are used. Furthermore, information from longitudinal studies is scarce. Thus, MaNuEL researchers made use of longitudinal datasets available within the Knowledge Hub, and harmonized and meta-analysed these six datasets to identify determinants of incident malnutrition in community-dwelling older adults. Using the same definition of incident malnutrition in all studies (i.e. BMI < 20 kg/m^2 at follow-up or weight loss $\geq 10\%$ between baseline and follow-up), among 21 potential baseline determinants and 2 follow-up variables (hospitalization, falls), 6 variables were identified as independent determinants of incident malnutrition in 4844 community-dwelling adults aged 65 years or older: age, marital status, difficulties walking, difficulties climbing stairs and hospitalization before baseline as well as hospitalization during follow-up [10].

These results were in line with those found in one of the included studies, The Irish Longitudinal Study on Ageing (TILDA), which was in parallel analysed separately with additional stratification by sex. In 916 male participants,

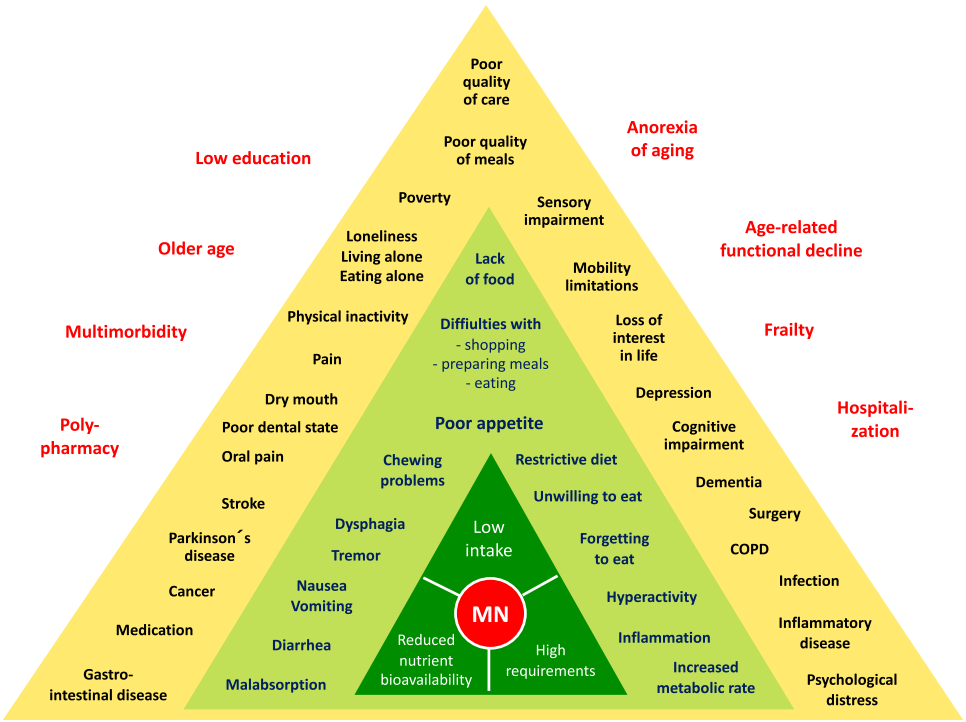

Fig. 1 Determinants of malnutrition in aged persons (DoMAP) model [9]. All factors—independent of the level—are regarded as (potential) "determinants" of malnutrition (MN) meaning that they may contribute to the development of MN in a causative manner. The levels illustrate different modes of action: Level 1 (dark green): central etiologic mechanisms. Level 2 (light green): factors in this level directly lead to one of the three mechanisms in level 1 (e.g. swallowing problems may directly cause low intake). Level 3 (yellow): factors in this level may indirectly lead to one (or more) of the three central mechanisms through one (or more) of the direct factors in the light green triangle (e.g. stroke may cause low intake via dysphagia or difficulties with eating). Surrounding factors in red are age-related changes and general aspects which also contribute to the development of malnutrition, but act even more indirectly or subtle

hospitalization in the previous year, falls during follow-up, and self-reported difficulties climbing stairs were found to be related to incident malnutrition. In 925 females, in contrast, receiving social support and cognitive impairment were significantly associated with incident malnutrition in the multivariate model [11].

Another secondary data analysis performed within the MaNuEL Knowledge Hub focused on oral health determinants of incident malnutrition in community-dwelling older adults using data from 893 participants, aged 55–80 years from the Longitudinal Aging Study Amsterdam. Among 19 factors affecting oral health, only toothache while chewing was significantly related to incident malnutrition in Cox proportional hazard models adjusted for various confounders. Poor oral health and xerostomia in edentulous participants narrowly missed reaching statistical significance [12].

Finally, a systematic approach was used to examine the existing evidence from prospective studies across all settings focusing on potentially modifiable determinants of malnutrition. Based on 23 studies (most with high risk of bias) and 30 determinants from seven domains, moderate evidence was found that poor appetite, eating dependency, poor self-perceived health, poor physical function and hospitalization are determinants of malnutrition. Moderate evidence also suggests that several factors, namely chewing difficulties, mouth pain, gum issues, co-morbidity, visual and hearing impairments, smoking status, alcohol consumption, physical activity level, impaired taste of food and specific nutrient intake are *not* determinants of malnutrition. Strong robust evidence is, however, lacking for the majority of determinants, and due to the heterogeneity of studies described above, pooling of data in a meta-analysis was not possible [13].

Based on these MaNuEL research activities, the following recommendations can be derived regarding determinants of malnutrition: in clinical routine, potential determinants should be assessed as comprehensively as possible. The DoMAP model may be helpful in this regard after further validation. As malnutrition is a multifactorial problem, the analysis of single factors is of limited benefit. In the case of functional impairment and hospitalization in particular, a potential risk of malnutrition should be assumed, as these factors repeatedly appeared in relation to incident malnutrition in prospective analysis. Regarding research, high-quality prospective cohort studies with standardized methodology—regarding the definition of malnutrition, the assessment of determinants as well as data analysis—are required.

Effective nutritional interventions

To optimally prevent or treat malnutrition in older adults, effective and evidence-based nutritional interventions should be identified and made readily available in all settings. MaNuEL researchers, in collaboration with researchers from the SENATOR Optimal Evidence-Based Non-drug Therapies in Older People (ONTOP) project, performed a systematic literature review to evaluate the effect of non-pharmacological interventions for the treatment of malnutrition in older persons [14]. In 11 randomized controlled trials, oral nutritional supplementation (ONS) was compared with usual care. Based on two meta-analyses, no beneficial effects of ONS treatment were observed on body weight change (six studies) or on body mass index change (two studies). Moreover, no effect on Mini Nutritional Assessment score, muscle strength, activities of daily living, Timed Up&Go test, quality of life and mortality was observed. Results of randomized controlled trials, in which ONS was combined with dietary counselling, were inconsistent. A careful quality assessment was conducted of all primary studies. Unfortunately, many studies had a high risk of selection bias and/or small sample size. Only a limited number of outcomes were addressed in these studies and a specific single outcome was included in only few studies, thereby, not permitting meta-analyses.

Another approach taken by MaNuEL researchers to evaluate the current evidence for nutritional treatment effects in malnourished older persons was the analyses of individual patient data from nine previously conducted randomized controlled trials that studied the effect of ONS, dietary counselling, or both on total energy intake and body weight [15]. Based on data from 990 older study participants who at baseline were malnourished or at risk of malnutrition, an overall beneficial effect on body weight, but not on energy intake, was observed. Stratifying by type of intervention, beneficial effects on both body weight and energy intake were only observed for ONS combined with dietary counselling in comparison to usual care. Of interest, the intervention effect on increase in energy intake was greater for women, older participants, and those with lower BMI, suggesting that some participants may benefit more from the intervention than others. Using a similar approach investigating handgrip strength and 6-month mortality as relevant outcome measures of the nutritional intervention, no beneficial effects were observed [16].

These MaNuEL results indicate that body weight and body mass index have been most frequently used to evaluate the effect of nutritional intervention in malnourished older persons. More high-quality trials with a low risk of bias are needed to test the effect of treatment on other relevant outcomes. Using a Delphi approach, MaNuEL researchers in collaboration with SENATOR ONTOP researchers used a standardized list of 13 potentially relevant outcomes (as identified in the systematic literature review above) to determine the most relevant outcomes according to nutrition experts and according to geriatricians [17]. Ratings were categorized into low importance (score 1–3), important but non-critical (score 4–6), and critical (score 7–9). The following five outcomes were considered as critical outcomes by the full group of experts: mortality, morbidity, functional status, nutritional status and quality of life. The outcomes mortality, morbidity and functional status were only rated as critical by geriatricians, while the nutrition experts also rated nutritional status, changes in dietary intake, compliance with the intervention, quality of life, and frailty status as critical outcomes. It was concluded that consensus on relevant clinical outcomes for nutritional intervention studies in older malnourished persons or those at risk of malnutrition is necessary. Consensus and actual use of these outcomes in future trials will allow meta-analyses of these trials and statistical analyses using individual patient data. This will subsequently benefit the development of evidence-based nutritional treatment guidelines for older adults. Currently, a protocol for an international Delphi study is being prepared by MaNuEL researchers to reach consensus on a set of relevant clinical outcomes (a Minimum Data Set) per setting to be used in future nutritional intervention studies treating malnutrition in older persons.

Regarding the current treatment of older persons who are malnourished or at high risk of malnutrition in clinical practice, it is recommended to combine both ONS and dietary counselling whenever possible as part of a comprehensive, individualized intervention approach. The recently published *ESPEN guideline on clinical nutrition and hydration in geriatrics* should be used to support intervention decisions [18].

Regarding future research on the effect of nutritional interventions in older persons for the treatment of malnutrition, the following recommendations can be made. First, assess nutritional status, appetite and total dietary intake for a comprehensive baseline characterization and monitor these variables during treatment. Second, consider patient-centred outcomes such as quality of life and physical functioning. Third, obtain specific informed consent from participants to allow the data collected to be re-used to address future research questions. Fourth, secure store collected data in a dataset at the most detailed level possible (e.g. keep the information on individual items within the malnutrition screening tool used and not just the total screening score) to re-use as much information as possible in future studies. Fifth, share coded individual participant data with other researchers to allow meta-analyses and pooled analyses. Finally, as soon as consensus has been reached on the Minimum Data Set of study outcomes (see above), include these outcome measures in all studies undertaken.

Current policies

National policy regarding the screening and treatment of malnutrition in older persons varies between countries. MaNuEL researchers completed an inventory of current policies across Europe to describe between country differences and to obtain examples of potentially effective policy measures. A web-based questionnaire was developed through a modified two-round Delphi consultation process with 24 international experts from the MaNuEL consortium to obtain information on current policies (i.e. existing laws and guidelines) regarding malnutrition screening and treatment in older persons in three health care settings (community, hospital and residential care). A link to this online, 22-item questionnaire was sent by a personalized email invitation to 95 contacts of relevant national stakeholders and political bodies in 28 EU countries plus Switzerland, Iceland and Norway, of which 19 countries completed the questionnaire. Overall, seven countries (36.8%) reported not to have any existing laws or policy documents providing recommendations on screening or treatment of malnutrition in older adults, while only four countries (21.1%) had existing laws or policy documents for both screening and treatment. The proportion of countries with existing guidelines for screening and treatment, respectively, was highest for the hospital setting [13 and 13 countries (out of 19 countries)] and lowest for the community setting [9 and 7 countries (out of 16 countries)], with intermediate values for the residential care setting [10 and 8 countries (out of 16 countries)]. The proportion of countries with existing laws regarding screening and treatment, respectively, was much lower (8 and 8 countries for the hospital setting, 7 and 5 countries for the residential care setting, and only 4 and 3 countries for the community setting).

Based on the MaNuEL findings, the following policy recommendations were developed. More effort is needed to implement binding norms for early detection and treatment of malnutrition in older persons, especially for the community setting. Moreover, prevention, detection and management of malnutrition should be obligatorily included in medical treatment and should not depend on individual caregivers' knowledge and/or engagement. Finally, national health system policies on quality management in hospitals, nursing homes and home care should include implementation of screening for malnutrition, adequate nutritional treatment and monitoring of standards.

Education of health professionals

One main barrier to the implementation of adequate nutritional interventions in older persons is assumed to be the lack of knowledge of health care professionals about this topic. To clarify to what extent European nurses and medical doctors are exposed to the topic of malnutrition in older adults during their professional education, MaNuEL researchers conducted two web-based online surveys to gain information about the curricula content on malnutrition in basic study programmes for these health care professionals.

A total of 131 nursing education institutions from 26 European countries responded to the survey (response rate 14%), of which 74% reported to address the topic of malnutrition in older adults. Malnutrition screening (71%), causes (67%) and consequences (69%) of malnutrition were frequently addressed topics, whereas cooperation in multidisciplinary nutrition teams (28%), dietary counselling (32%) and the responsibilities of various professions in nutritional support (35%) were less often taught [19].

Based on these results and taking selection bias of nutrition-interested participating institutions into account, it can be concluded that the topics of malnutrition and malnutrition screening are currently not included in nurse education at many European educational institutions. To provide an opportunity for nurses to learn about this topic, MaNuEL partners from Austria subsequently started to develop a "Massive open online course (MOOC)" that would allow nurses to educate themselves about malnutrition in older persons. The course is currently available in the German language with English subtitles and is freely accessible on the internet [20].

From the addressed medical schools only 26 (response rate 8%) from 12 European countries completed the online questionnaire. Half of them stated having the topic of malnutrition in older adults included as part of the medical students' curricula. Most commonly taught issues were causes (50%), assessment (50%) and consequences (46%) of malnutrition. Thirty-five percent of the institutions reported addressing the topic of malnutrition screening [21].

Based on these MaNuEL results, we strongly recommend an evaluation, and if necessary an improvement, of nursing and medical school curricula content in Europe with respect to the topic of malnutrition in older adults to enable nurses and physicians to provide high-quality nutritional care for their patients. A special focus should be placed on multidisciplinary cooperation, which could be initiated by integrative teaching targeting all professional groups in joint teaching. Healthcare professionals should also be encouraged to take additional courses for continuing professional training. Overall, national and international initiatives are required to create a higher level of awareness and promote improvements in nutrition education for healthcare professionals. The potential impact of nutritional education on the topic of malnutrition of older persons and their caregivers also deserves further scientific attention [22].

Conclusions

During the 2-year MaNuEL Knowledge Hub, our unique, international consortium of malnutrition experts delivered a wealth of new evidenced-based information regarding malnutrition in older persons. This information was based on systematic literature searches, secondary data analyses of previously collected data from cohorts and nutrition intervention trials, as well as newly conducted Delphi studies and web surveys. The MaNuEL output extends scientific knowledge and has led to recommendations for evidence-based practice in the management of malnutrition in older persons, policy recommendations as well as recommendations for the education of health professionals regarding malnutrition in older persons. Furthermore, important knowledge gaps have been identified which need to be addressed in future studies.

Based on MaNuEL outputs, the MaNuEL Toolbox was developed to effectively distribute and disseminate the MaNuEL results. This Toolbox can be downloaded at no cost at: https://www.stuurgroepondervoeding.nl/wp-content/uploads/2018/11/MaNuEL-Toolbox_Oct2018_final.pdf. Furthermore, presentations by MaNuEL researchers of MaNuEL results can be viewed online at https://av-media.vu.nl/VUMedia/Play/8bb85270414043d6aa746f494cbb3ef91d.

The knowledge obtained in MaNuEL will benefit researchers, healthcare professionals, policy-makers as well as educational institutes to further advance their direct or indirect contributions to the optimal prevention, screening and treatment of malnutrition in older persons. These advancements will importantly contribute to tackling the increasing problem of protein–energy malnutrition in the older population.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study, formal consent is not required.

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